Proposed Control Measure to Reduce Emissions from Small Off-Road Engines (SORE)

Monitoring and Laboratory Division
Planning and Technical Support Division
Mobile Source Control Division
California Air Resources Board

April 25, 2002

Elements of SORE Control Measure

- Exhaust Element
  - Revises exhaust emission standards for non-handheld equipment
- Evaporative Element
  - New evaporative emission standard for walk-behind mowers (WBMs)
  - Requires new fuel tanks to meet a permeation standard (applicable to all handheld and non-handheld SORE categories)
  - Proposing design-based certification requirements

Goals of the Evaporative Element of SORE Control Measure

- Reduce diurnal evaporative emissions from non-handheld equipment by 70% (17.6 TPD)
- Reduce diurnal evaporative emissions from handheld equipment by 40% (1.5 TPD)
- Use readily available technology to reduce emissions
- Allow flexible certification requirements to reduce burden on industry

Status of the Regulatory Effort

- Identified evaporative emission processes
- Finalizing OFFROAD emissions inventory
- Developed evaporative emission test procedures
- Quantified SORE evaporative emissions
- Performed emission reduction testing
- Developing draft regulatory language

Evaporative Emission Processes

- Running Loss Emissions
  - Evaporative emissions that occur during equipment operation
- Hot Soak Emissions
  - Evaporative emissions that result from latent heat
  - Typically generated for a one-hour period after equipment operation
- Diurnal Emissions
  - Evaporative emissions that result from daily temperature variations
  - Includes permeation emissions (fuel line and tank)

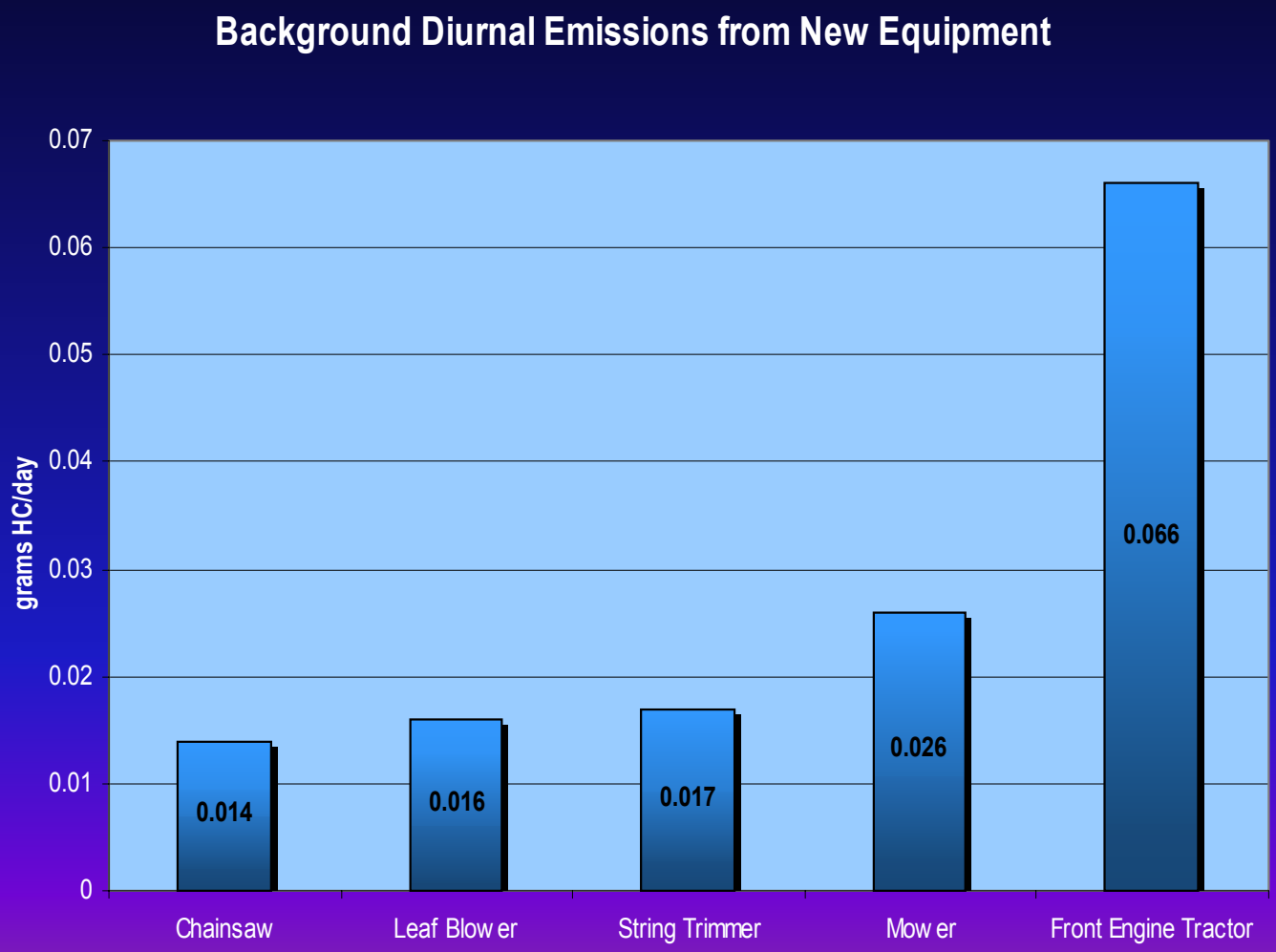
Status of Inventory Development

- Contract testing at Automotive Testing Laboratories (ATL) nearly complete
- Will repeat wintertime testing with winter pump fuel (High RVP) to develop temperature correction factor
- Have requested a contract augmentation to perform additional tank replacement testing on handheld and large non-handheld equipment
- Performing data reduction to modify current OFFROAD emission factors

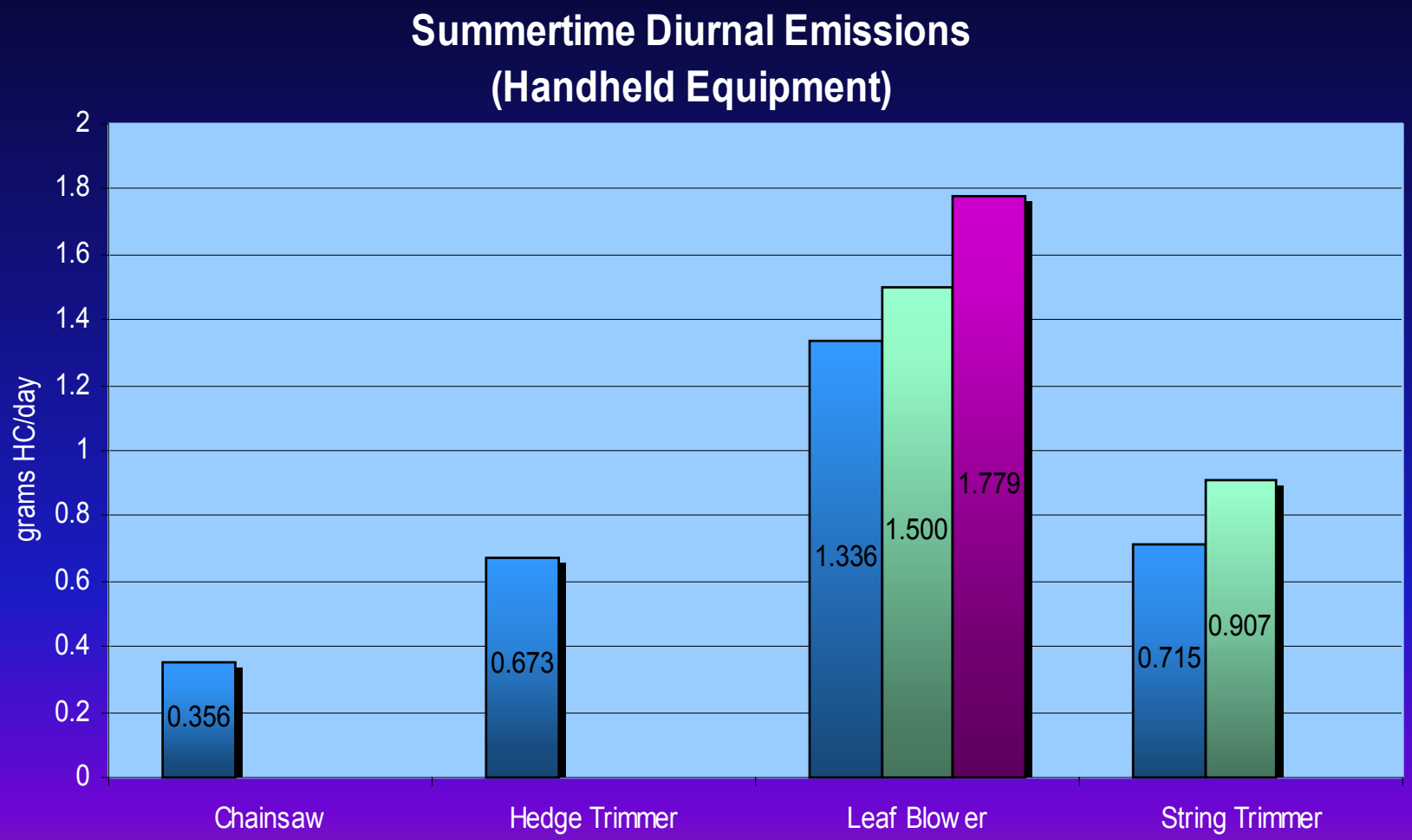
In-House Evaporative Emissions Testing

- Baseline Emissions
  - Background diurnal emissions from new equipment
  - Summertime hot soak and diurnal emissions
  - Summertime ROG emissions using fuel containing ethanol
  - Fuel tank vented emissions
  - Wintertime hot soak and diurnal emissions
  - Fuel tank permeation emissions
- Emissions Reduction Testing
  - Walk-behind mowers
  - Barrier treated HDPE fuel tanks

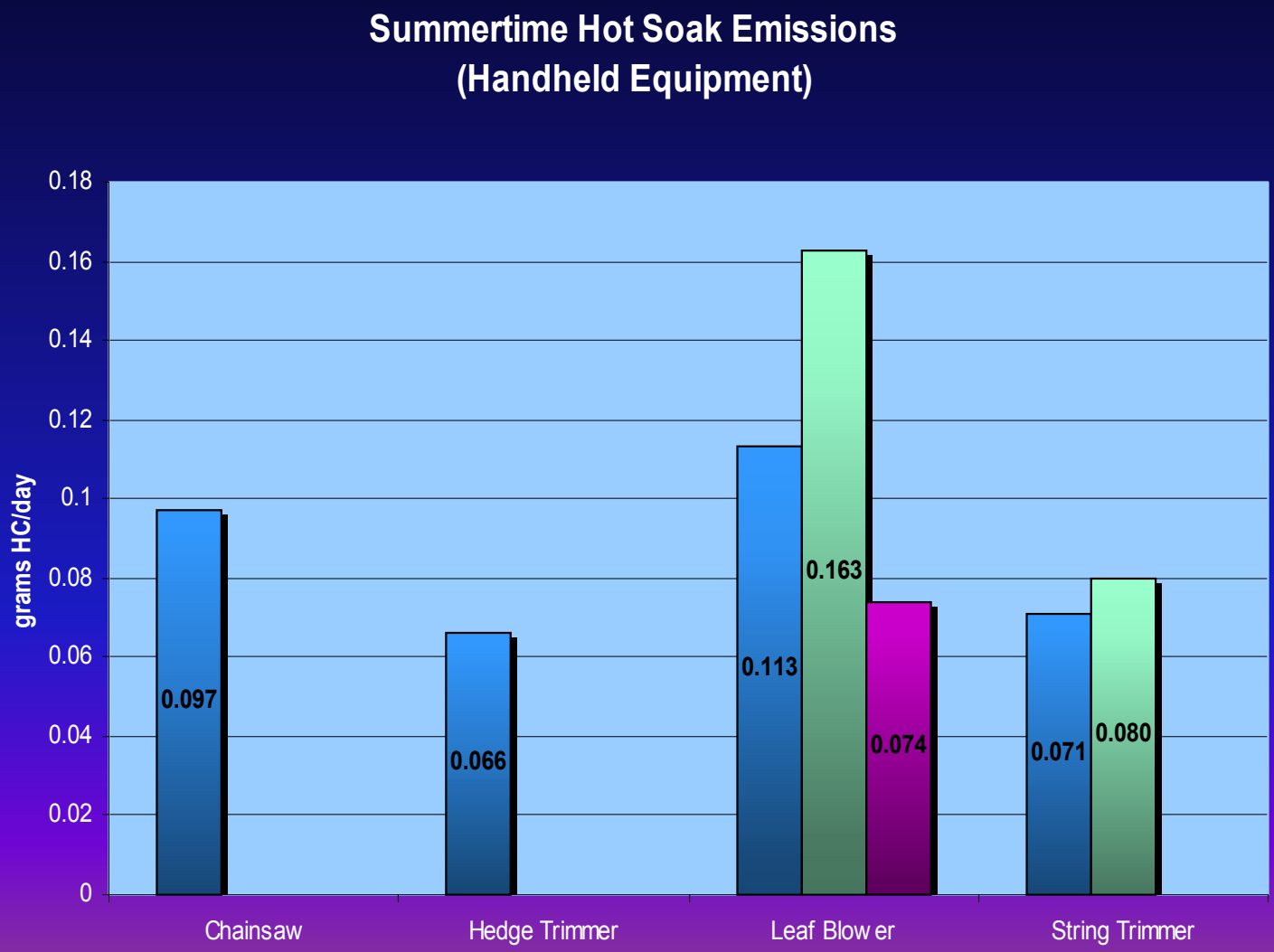
- Manufactured at least one month prior to testing
- Emissions less than 0.1 gram/day



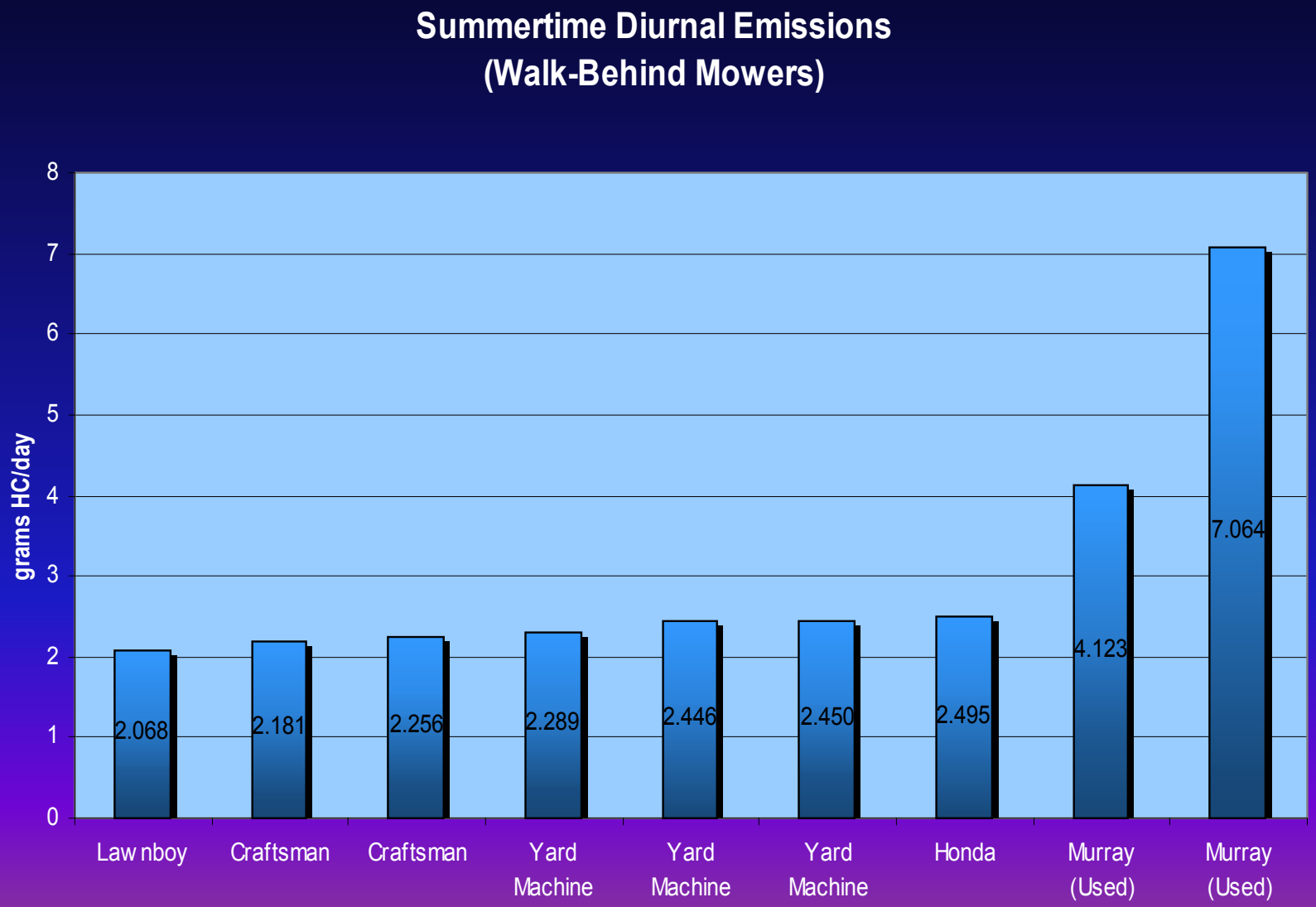
- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (65°F - 105°F - 65 °F)
- Emissions below 1.0 gram/day except for leaf blowers



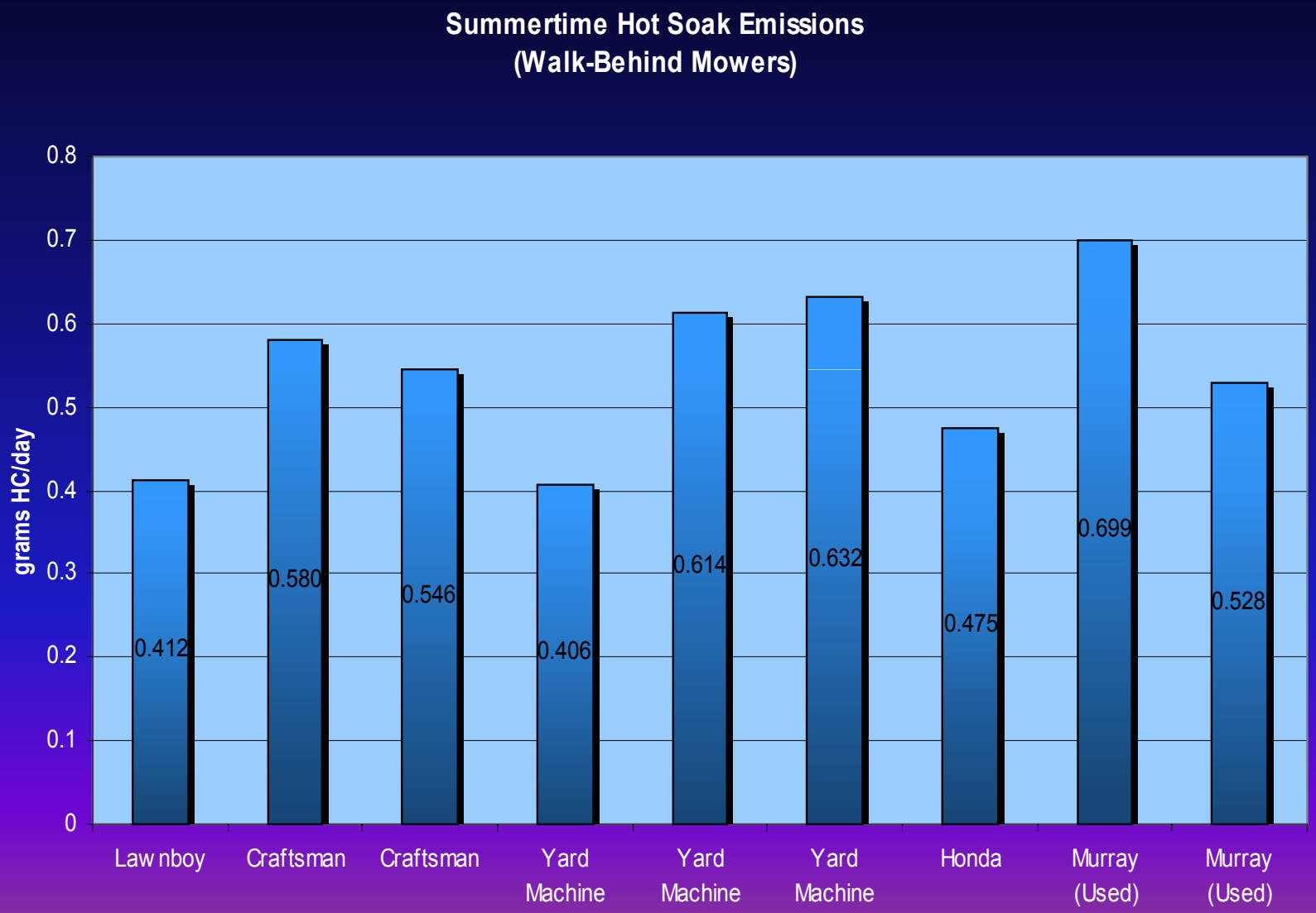
- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (1-hour @ 95°F)



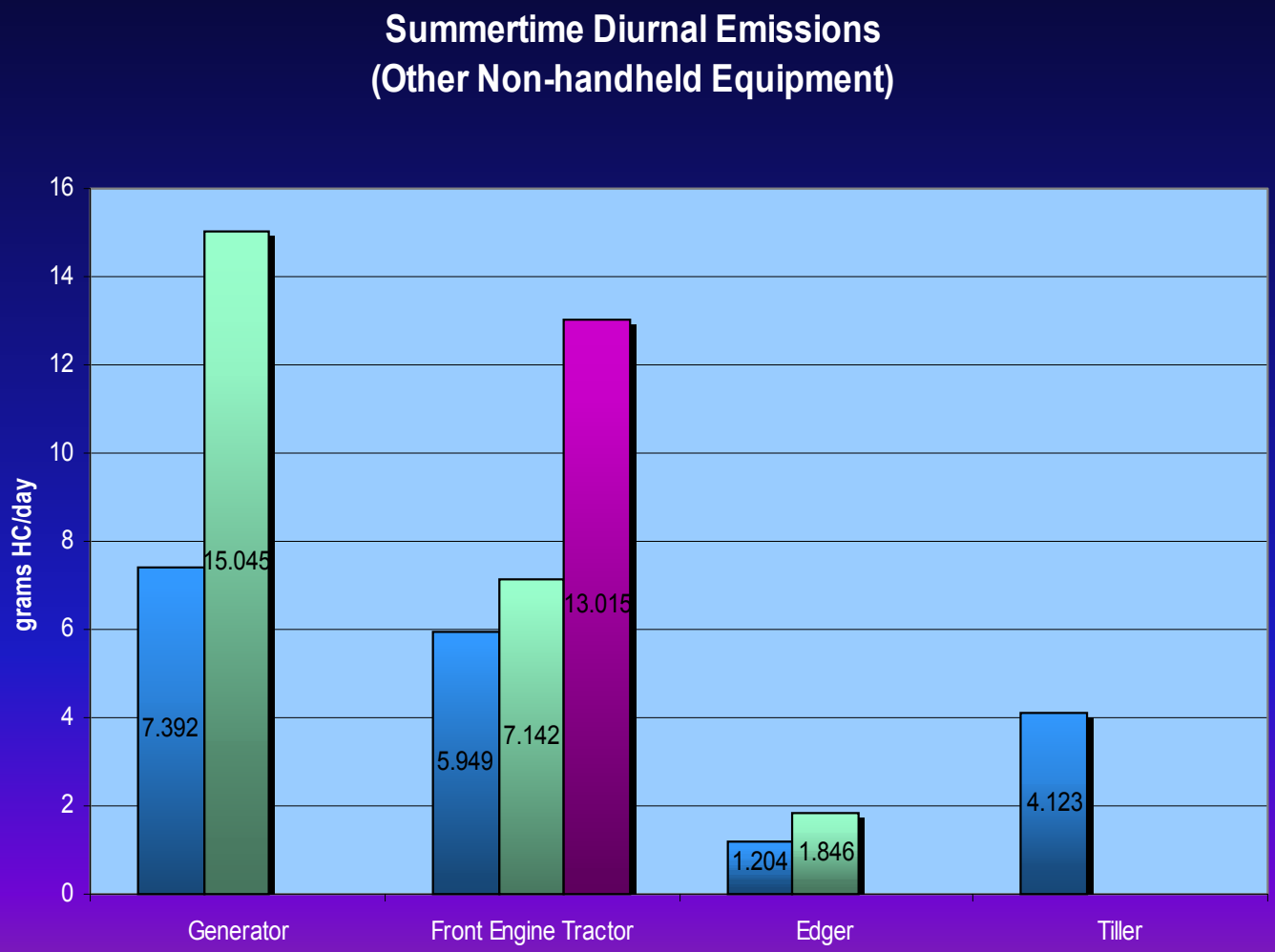
- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (65°F - 105°F - 65 °F)
- Average diurnal emissions from new mowers 2.312 grams/day



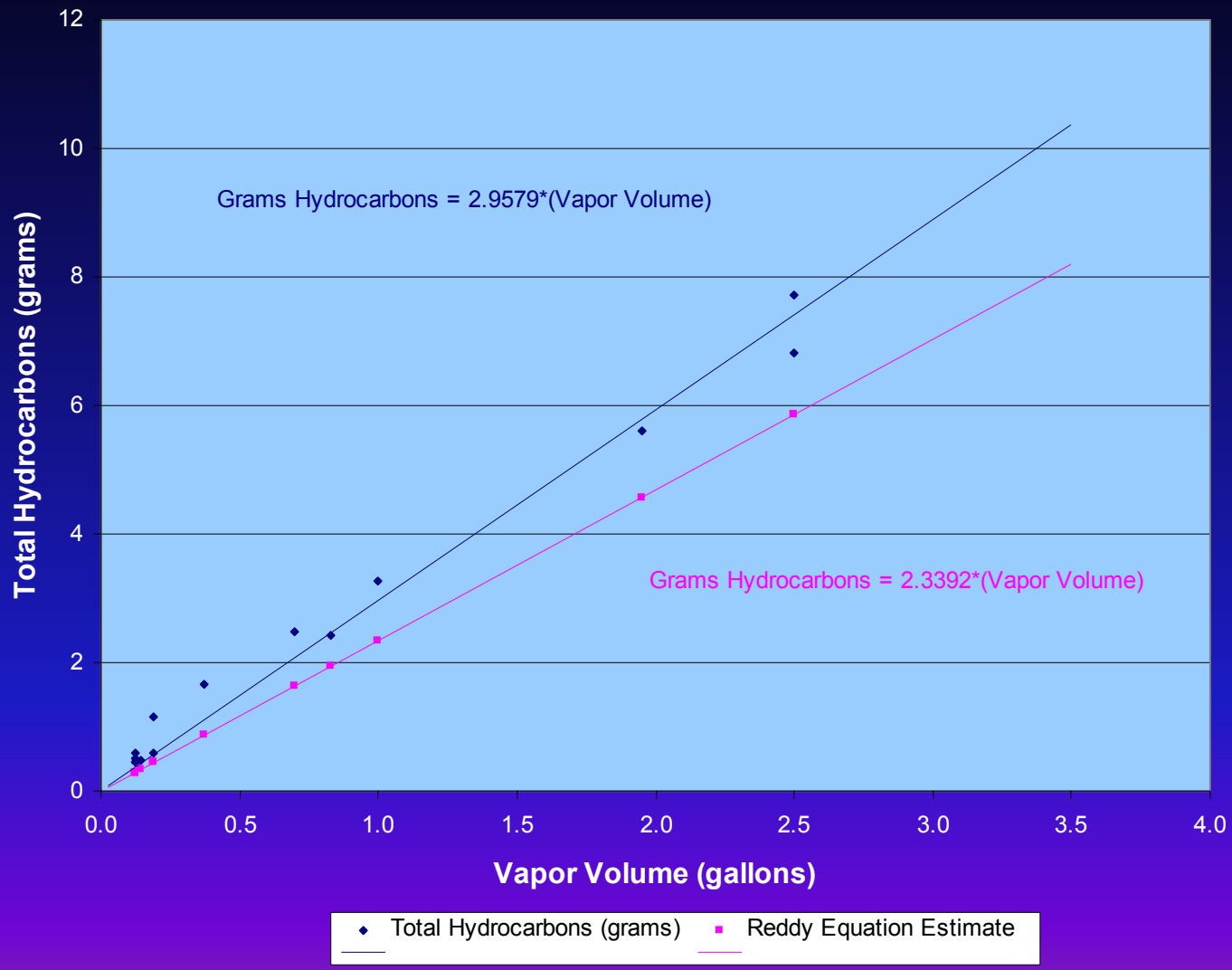
- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (1-hour @ 95°F)
- Average hot soak emissions from new mowers 0.524 grams/day



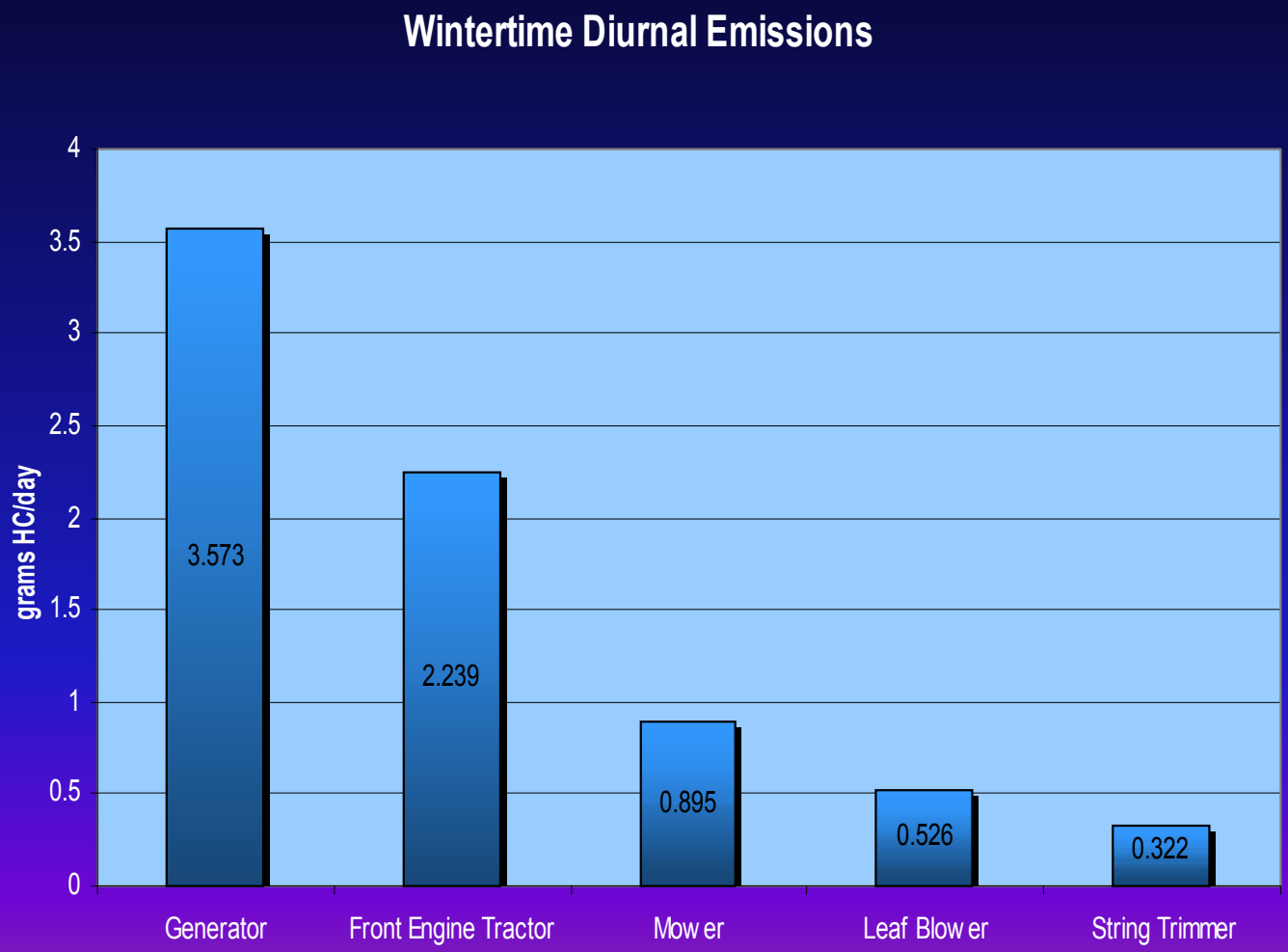
- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (65°F - 105°F - 65 °F)
- Large (> 0.5 gal) vented fuel tanks are a major source of emissions



Diurnal Emissions from Passively Vented HDPE Off-Road Equipment Fuel Tanks



- Test fuel - summertime pump (low RVP, ~ 7 PSI)
- Temperature profile - (48.5°F - 69.5°F)
- Emissions significantly lower



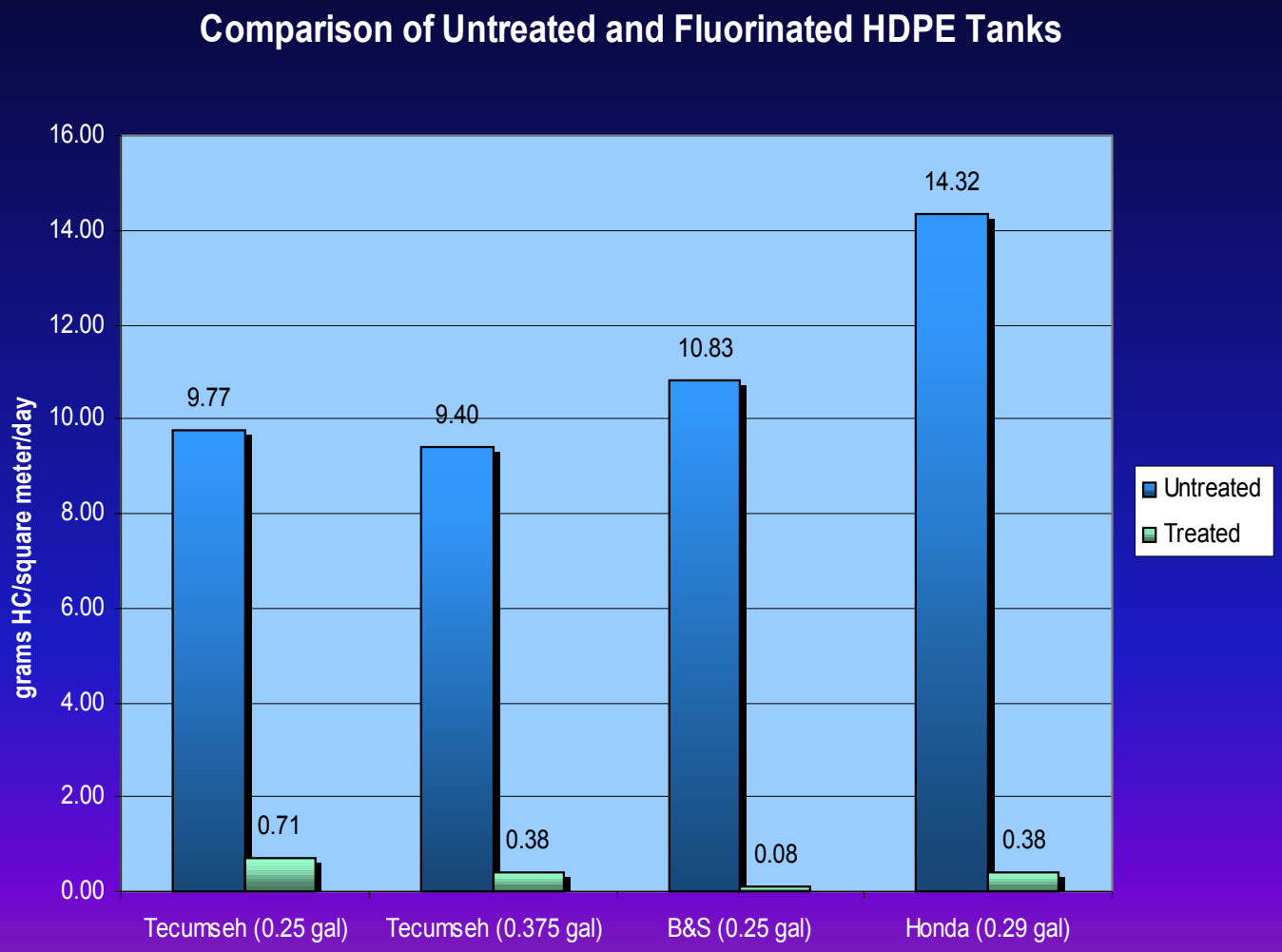
Fuel Tank Permeation Emissions (Untreated HDPE Tanks)

- Tanks soaked for 30 Days
- Certification fuel used for testing
- Subjected to multiple diurnal profiles
- Permeation result is the average daily weight loss divided by the internal surface area
- Thick Walled Tanks (> 0.125”)
  - Avg. handheld permeation rate (6.39 grams/m^2/day)
  - Avg. large non-handheld permeation rate (5.92 grams/m^2/day)
- Thin Walled Tanks (< 0.125”)
  - Avg. small non-handheld permeation rate (10.60 grams/m^2/day)

Fuel Tank Permeation Emissions (Fluorinated HDPE Tanks)

- 19 Tanks treated to level 5 fluorination
- Tanks soaked for 30 days
- Certification fuel used for testing
- Subjected to multiple diurnal profiles
- Permeation result is the average daily weight loss divided by the internal surface area
  - Avg. permeation rate ~ 0.84 grams/m^2/day
  - 92% Level of reduction

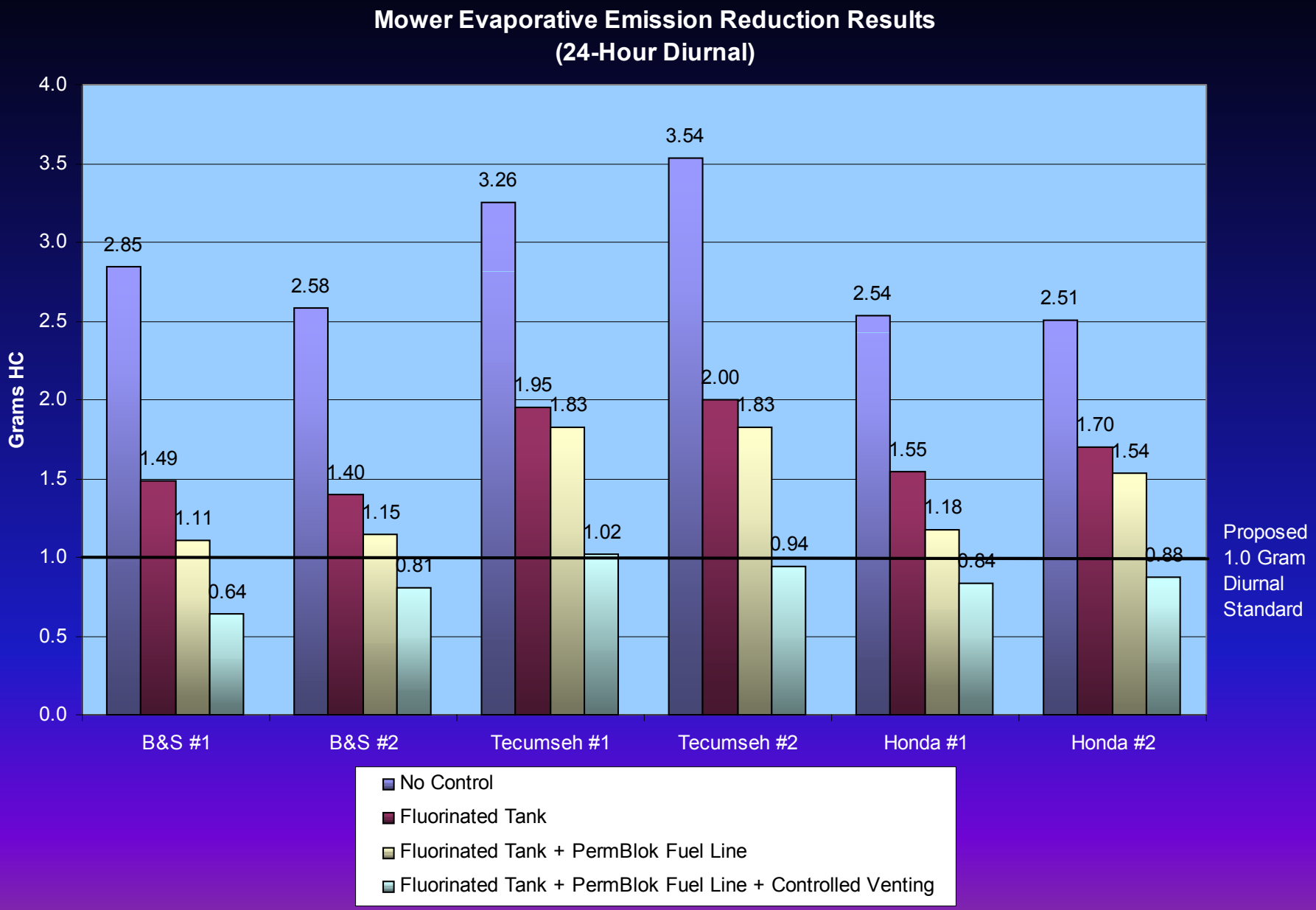
- **Results for Typical HDPE Mower Tanks**
- **92% Level of reduction**

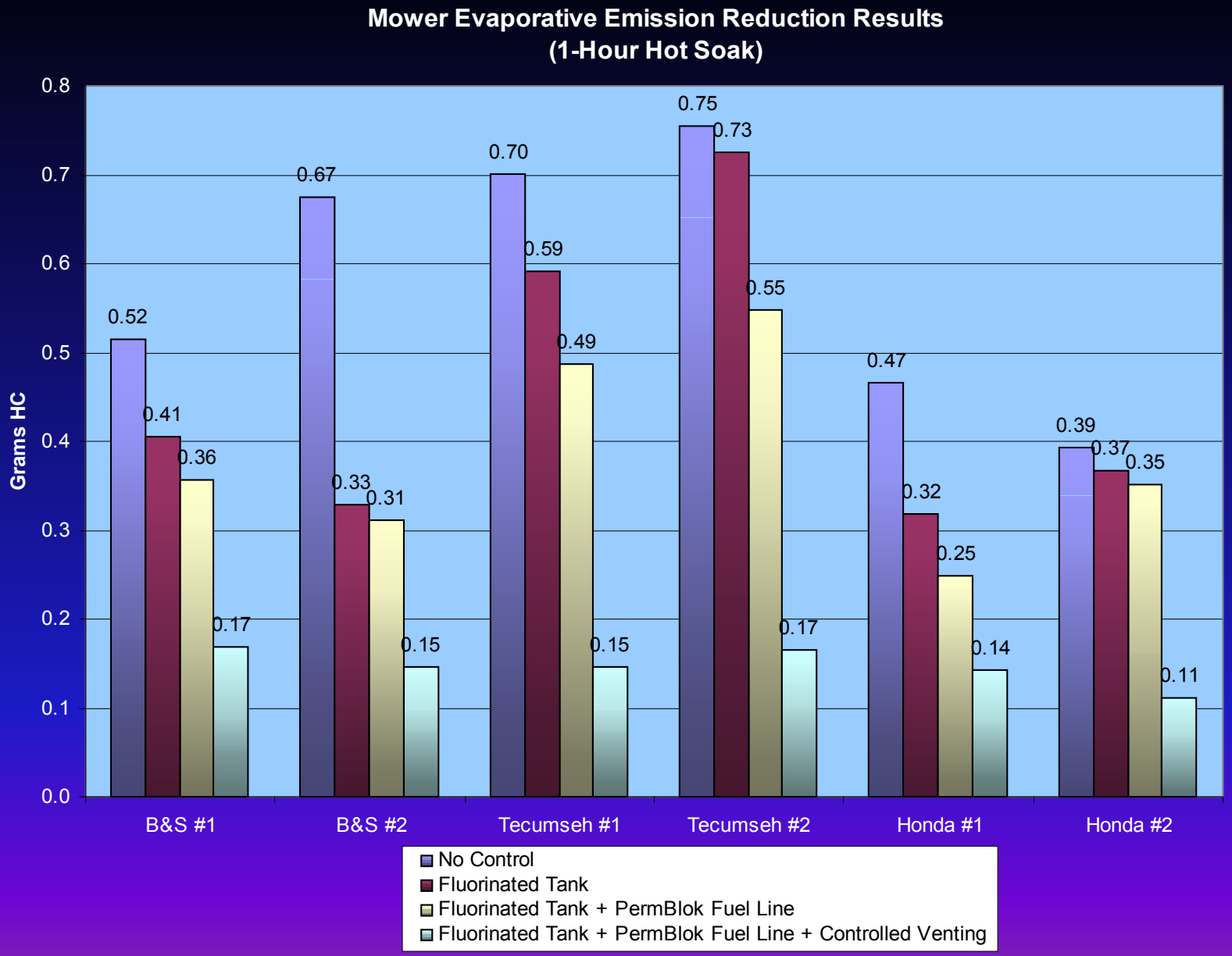


Emission Reduction Testing Summary for Walk-Behind Mowers (WBMs)

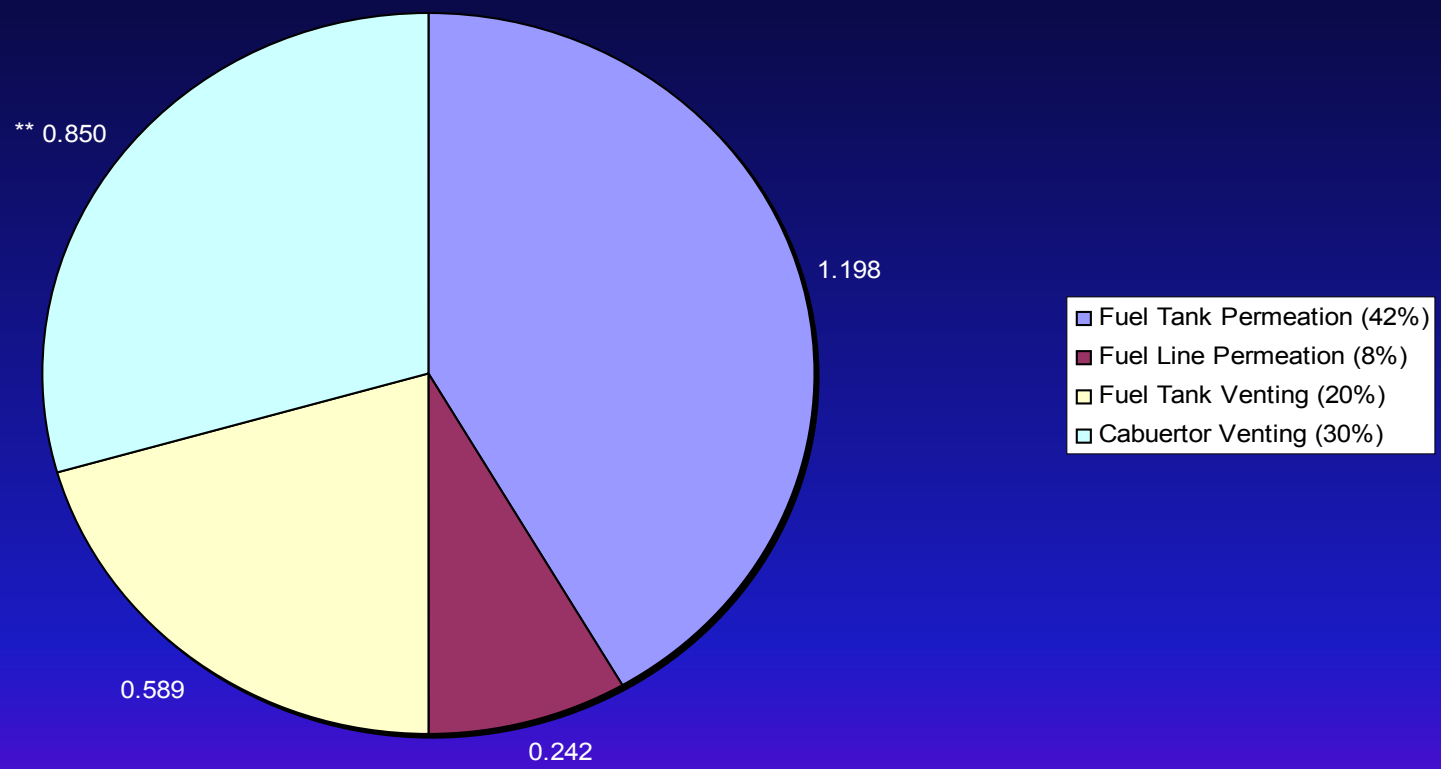
- Three pairs of popular mower engines tested (B&S Intek, Tecumseh Magna Torque, Honda GCV 160)
- Measured hot soak and diurnal emissions in SHED
- Summer pump fuel used for testing
- Equipment tested in four phases
  - Baseline with no controls, phase I
  - With fluorinated tank, phase II
  - With fluorinated tank and PermBlok fuel line, phase III
  - With fluorinated tank, PermBlok fuel line, and controlled venting mechanism, phase IV

Phase IV Configured Honda Mower


Mower Evaporative Emission Reduction Results
(24-Hour Diurnal)
Grams HC
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.85
1.49
1.11
0.64
2.58
1.40
1.15
0.81
3.26
1.95
1.83
1.02
3.54
2.00
1.83
0.94
2.54
1.55
1.18
0.84
2.51
1.70
1.54
0.88
B&S #1
B&S #2
Tecumseh #1
Tecumseh #2
Honda #1
Honda #2
Proposed
1.0 Gram
Diurnal
Standard
No Control
Fluorinated Tank
Fluorinated Tank + PermBlok Fuel Line
Fluorinated Tank + PermBlok Fuel Line + Controlled Venting


Mower Evaporative Emission Reduction Results
(1-Hour Hot Soak)
Grams HC
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.52
0.41
0.36
0.17
0.67
0.33
0.31
0.15
0.70
0.59
0.49
0.15
0.75
0.73
0.55
0.17
0.47
0.32
0.25
0.14
0.39
0.37
0.35
0.11
B&S #1
B&S #2
Tecumseh #1
Tecumseh #2
Honda #1
Honda #2
No Control
Fluorinated Tank
Fluorinated Tank + PermBlok Fuel Line
Fluorinated Tank + PermBlok Fuel Line + Controlled Venting

Distribution of Uncontrolled Evaporative Emissions from WBM
(Average of 2.879 grams HC per 24-hour Diurnal Test)



** Remaining emissions attributed to carburetor

Previously Proposed Diurnal Standard for WBMs

- Maximum allowable diurnal emissions
  - (1.0 grams HC/day)
- Result must be obtained with a 40 CFR Part 86 compliant SHED
- Temperature profile - (65°F - 105°F - 65 °F)
- Test fuel - California certification fuel
- Fill level - tank will be tested at a 50% Fill Level
- Diurnal test must be performed after a 1-hour hot soak test and subsequent 2-hour cold soak at 65 °F

New Proposal

- Design-Based Standard
  - Requires no SHED testing by manufacturers
  - Manufacturers not held to a specific numerical standard
  - Certification protocol to be developed
  - ARB performs in-use testing
- Design Standards would apply to all non-handheld portable equipment

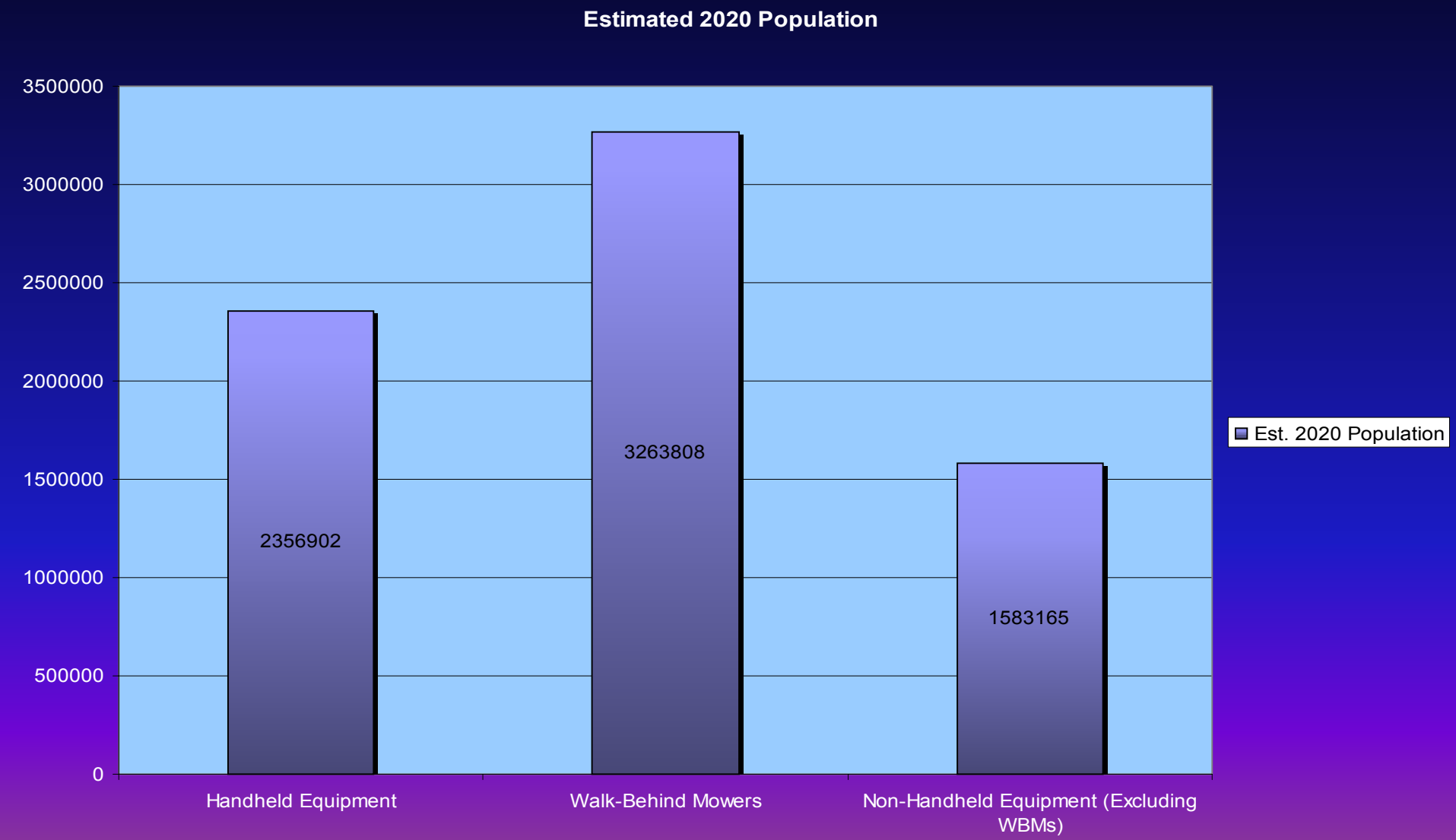
Example of Design Requirements for WBMs

- Certify by design
  - Use or specify a fuel tank that is automatically sealed when equipment is stored
  - Use or specify a fuel tank that meets a prescribed level of treatment
  - Use or specify a SAE 2260 category 1 low permeation fuel line
  - Use or specify a tethered fuel cap

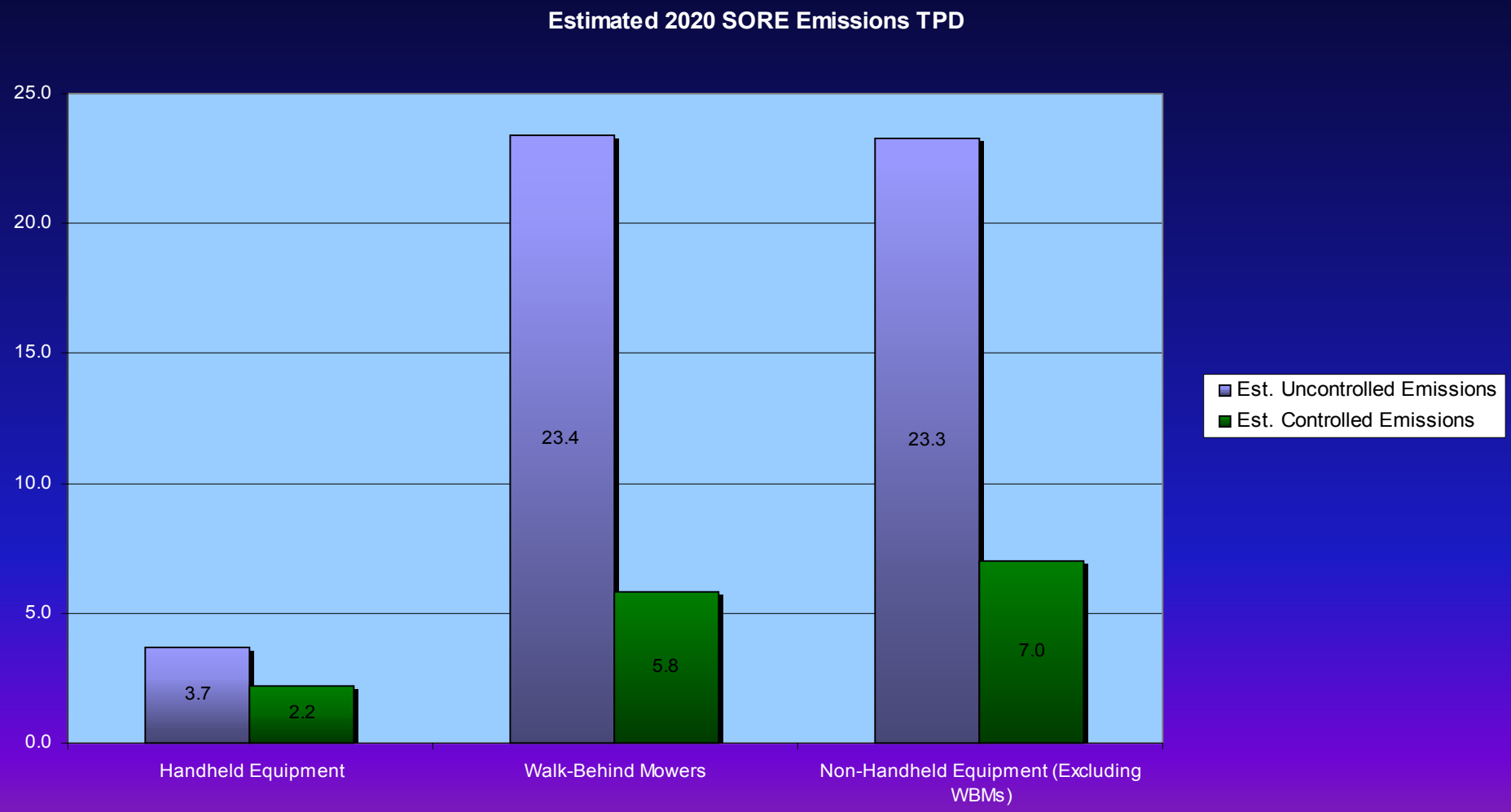
Our Estimated Costs of Evaporative Controls

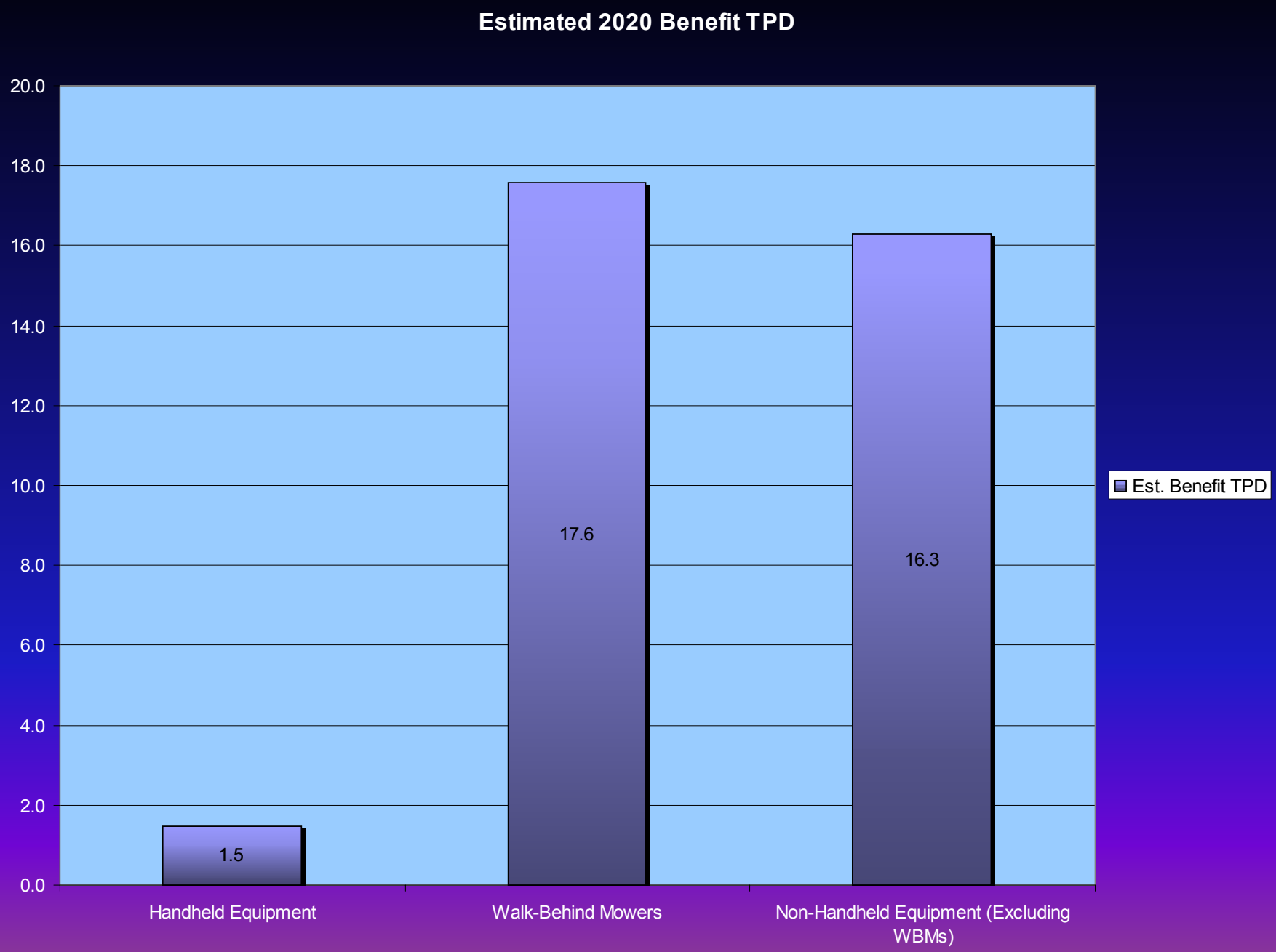
- Cost to Comply with the Permeation Standard ($2.00 - $3.00 per tank)
- Cost to Comply with the Design-Based Standard ($15.00 per unit)
  - Controlled venting mechanism - ($7.00 - $10.00)
  - Low permeation fuel line ($2.00)
  - Compliant fuel tank ($2.00 - $3.00)
- We Request Industry Estimates of the Cost to Produce Equipment that Meets the Proposed Design-Based Requirements

SORE Emissions Inventory and Anticipated Reductions



SORE Emissions Inventory and Anticipated Reductions Cont.




Estimated 2020 Benefit TPD
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1.5
17.6
16.3
Handheld Equipment
Walk-Behind Mowers
Non-Handheld Equipment (Excluding WBMs)
Est. Benefit TPD

Next Steps

- Conduct Additional Testing
  - Emission reduction testing with fuel containing ethanol
  - testing to ascertain barrier durability
  - Evaporative emission testing with catalysts
  - Development of wintertime correction factor for the OFFROAD model
- Develop Certification Procedures and Alternatives
- Develop Control Measure Cost Estimate
- Draft Proposed Regulatory Language and Staff Report

Current Schedule

Event or Task	Target Date
Additional Testing	*June, 2002*
Draft Regulatory Language	*July, 2002*
Third Workshop	*September, 2002*
Board Consideration	*December, 2002*

Contacts and Additional Information

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OREFT WEB Page URL
http://www.arb.ca.gov/msprog/offroad/sore/sore.htm

Conceptual WBM Certification Scenario